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RESEARCH IN MICRO-TERMINAL DEVELOPMENT AND NETWORK END-TO-END ERROR RECOVERY

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13. ABSTRACT

This report discusses the two tasks which are supported by the grant. They are presented as they were initially planned and as they have evolved over the first three months of the project.

In Task I, the Computer Systems Laboratory is to seek out the latest developments in miniature display, keyboard, storage, and micro-processors and incorporate these in the implementation of a highly portable computer terminal for individual use. Where devices do not exist to accomplish the task, the Laboratory is to direct and support research in the designated area. The proposed terminal will weigh less than 10 pounds, will have 8,000 words of computer storage and will equal certain minicomputers in performance. A small cassette will be added for auxiliary storage. The report discusses the progress toward realizing this goal.

In Task II, CSL is to investigate the requirements necessary for error-free, bi-directional communication between two terminals when the interconnection between terminals may not be under the control of the users themselves. For example when using a packet-switched commercial network. Processors to accomplish this task are being implemented and design specifications are being formulated.

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14. KEY WORDS	LINK A		LINK B		LINK C	
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Integrity of Communications						

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COMPUTER SYSTEMS
LABORATORY--UCSB
31 December 1974

FIRST QUARTERLY TECHNICAL REPORT

RESEARCH IN MICRO-TERMINAL DEVELOPMENT AND NETWORK END-TO-END ERROR RECOVERY

I. PROJECT GOALS

The proposed research and development project, ending June 30, 1975, will include TASK I and TASK II with specific requirements as itemized below.

TASK I

Investigation of the requirements for, and the attributes of, a miniature "intelligent" terminal for use on a portable basis.

The development of design specifications for such a terminal, including references to commercially available component parts.

The implementation of a prototype terminal to establish the physical organization of a production terminal.

The fabrication of several field-test-units for evaluation.

A final report including recommendations for production units, fabrication documentation, and maintenance information.

TASK II

Investigation of the requirements and the application of end-to-end error checking and retransmission equipment for use on the Network.

Specification and implementation of a prototype pair of units for testing and demonstration. These units will probably contain programmable microprocessors and will be made to insure terminal-to-terminal integrity of the data being transmitted.

Consideration is to be given to a physical means for detection and correction of errors produced by the keyboard of the sending terminal and the printing mechanism in the receiving terminal.

II. APPROACH

A. Task I

A design term was organized and given the task of acquiring component parts for the terminal, from what is considered to be state-of-the-art equipment, and to implement the prototype.

The task was divided into four areas of investigation; the *processor*, the *display*, the *keyboard*, and *peripheral attachments*. The team was directed to pursue each area with vigor and to follow-up on every component which might fit within our restrictions on size and weight. The availability of selected components was to be determined and an implementation schedule was to be drawn up.

B. Task II

Researchers were assigned the task of implementing a pair of microprocessors with serial communication interfaces which would connect to standard terminal devices such as a Teletype and to the ARPANET by means of a TIP or Host. Programs within this processor pair are to transmit information from one unit to the other with full error recovery.

The two-man team which was assigned has experience with hardware and with Network protocol design.

III. TASK I - PROGRESS TO DATE

Charts showing availability of component parts are being drawn up. As our list of contacts widens we find near-term availability of the most appropriate components will be our major problem. The most useful Liquid Crystal Display, for example, may take from 1 to 2 years to get into production. Once our direction is established however, we believe that substitution of similar devices will allow the project to proceed.

The charts are not as yet complete but the design of the prototype is beginning to firm up. A realistic stop-gap machine with characteristics that will allow the change of individual elements as the preferred devices become available, is in the process of being specified.

The following paragraphs provide a view of the terminal specification as it was, and how it is evolving.

MICRO TERMINAL SPECIFICATION

A. Initial Specification

At the inception of the project we stated the terminal should have the following characteristics:

1. Portability - The terminal is to contain its own power supply, be readily carried by an individual, have the capability of being set up while seated at a small table such as in a commercial airplane.

2. Capability - The terminal must provide the user with text editing capability with as much versatility as can be built into the system. TECO-like command structure should be incorporated with those features that make the user's ability to deal with text and storage being emphasized. Storage must include the control programs, several pages of text for ready display, and magnetic tape storage for files and other information.

3. Display - The display should have a reasonable number of characters to represent a line of text and should have several lines displayed at one time. The user should be able to "scroll" through a page or more of text, both for review and for modification. The character set should contain standard symbols as well as regular alphanumeric presentation.

4. Peripherals - Attachments to the unit should include a magnetic tape cassette for storage and retrieval of files and a modem connection to allow data-set or acoustic coupler use.

B. Additional Data

Several events and factors have allowed us to narrow the range of decisions regarding implementation. These include:

1. Information from Bob Parker at USC-ISI regarding the acceptance and critique of his earlier portable terminal. To be acceptable to the user it must be less than 20 pounds in weight, it must have at least 40 characters in a line (not 32) so that it is more compatible with the line length used in TENEX, and it must have a keyboard which is large enough to allow typing by a person used to standard keyboards.

2. From our implementation of a TECO-like text editor for the IMLAC we found that the ability to scroll through a display of 4000 characters would make the terminal most useful, and that the text editor routines plus I/O modules should consume less than 4K bytes (8-bit).

3. Hughes Ground Systems Division has developed a special terminal for Forward Observer use which weights 16 pounds. They are projecting a reduction in weight to 9 pounds late in 1975. This special purpose terminal has fixed formating and a minimal keyboard which would prohibit it for consideration as an intelligent terminal. However, it does have a transmitter, a 2 pound battery that will sustain it for 24 hours in intermittent operation, and their 9 pound version will incorporate either new low-power LEDs from H-P or the Hughes' developed Liquid Crystal display.

Information gained from these sources has helped in establishing the guidelines and the preliminary specifications for the prototype unit.

C. Guidelines

Size of the terminal will be primarily influenced by the display and the keyboard. The major factor in weight reduction is the amount of power required to operate the terminal.

With regard to size, it was our opinion that the unit should be no larger than a flat shoe box, possibly opening like a chess set. We believe that the size can be decreased when A/N Liquid Crystal displays become available.

Along with the size, we have set a weight limit of 10 pounds for the terminal, including the batteries to operate it. In considering the batteries that are presently available and the power requirements for memory, display, and tape cassette, we have established that it might be possible to operate with a power consumption of 10 watts and we have placed this as our design goal. Our investigation of power sources is by no means complete but with a specially constructed power source, using rechargeable batteries available today, we can achieve more than 10 hours of continuous operation at somewhat over 10 watts. With our plans to reduce the duty cycle of major terminal components, this time can be extended.

D. Present Configuration

Figure 1 shows our present terminal organization. The power allotment for each of the major elements has been shown. Our choices for these elements are presently as follows:

1. Processor - RCA COSMAC or Intersil IM6100. The first has an inconvenient instruction set which might require tricky programming or cause inefficient utilization of program memory. The second looks like a PDP-8 (12 bit). Inselek and Intel project CMOS devices in 1975. These choices are made due to low power consumption. If the processor power allotment can be increased to 1 watt, we would choose a more capable N-MOS device such as the Motorola 6800 or Signetics 2650 PIP, either using only +5V.

2. Memory - Complementary Metal-Oxide Semiconductor (CMOS) memory chips have been designed specifically for low-power applications. CMOS is therefore expecially useful in protable equipment. CMOS RAMs are available from a number of manufacturers (see list below).

Intersil	IM6523	256x1
Motorola	MCM14537	256x1
Inselek	INS4200S	256x1
AMI	S222	512x1

Additionally a number of 1024 bit CMOS RAMs have been announced.

Intel	5101	256x4
Intersil	IM6508	-
RCA	-	1024x1, 256x4

Intel has announced a new low power version of their 4096x1 NMOS Dynamic RAM (Part # P-2107 A8).

Both of the above technologies are consistent with the design objectives. Additional trade-off studies at the system level, 8K bytes, are required to make the best choice.

3. Display - Low power LED for the interim and liquid crystal ultimately. For 2 lines of 40 characters the LED will require 4.4 watts. The liquid crystals power consumption is <100 mwatts.

In the case of the displays, we believe that liquid crystal is the only type that will fulfill the final goal. It has low power, can present great amounts of information (with magnification), and future circuitry will contain not only the display but drivers.

However, availability ranges from 3 months for the most minimum alphanumeric display, to 2 years for a full page display in a 1"x1" package. Factors that will influence this lead-time will be the pressure of the marketplace to cause manufacturers such as Hughes, ITEK, PMS, and others to come out with these products sooner; or, if we are willing to spend the $50,000 to $100,000 in helping to accelerate the pace of this development.

4. Keyboard - Undecided.

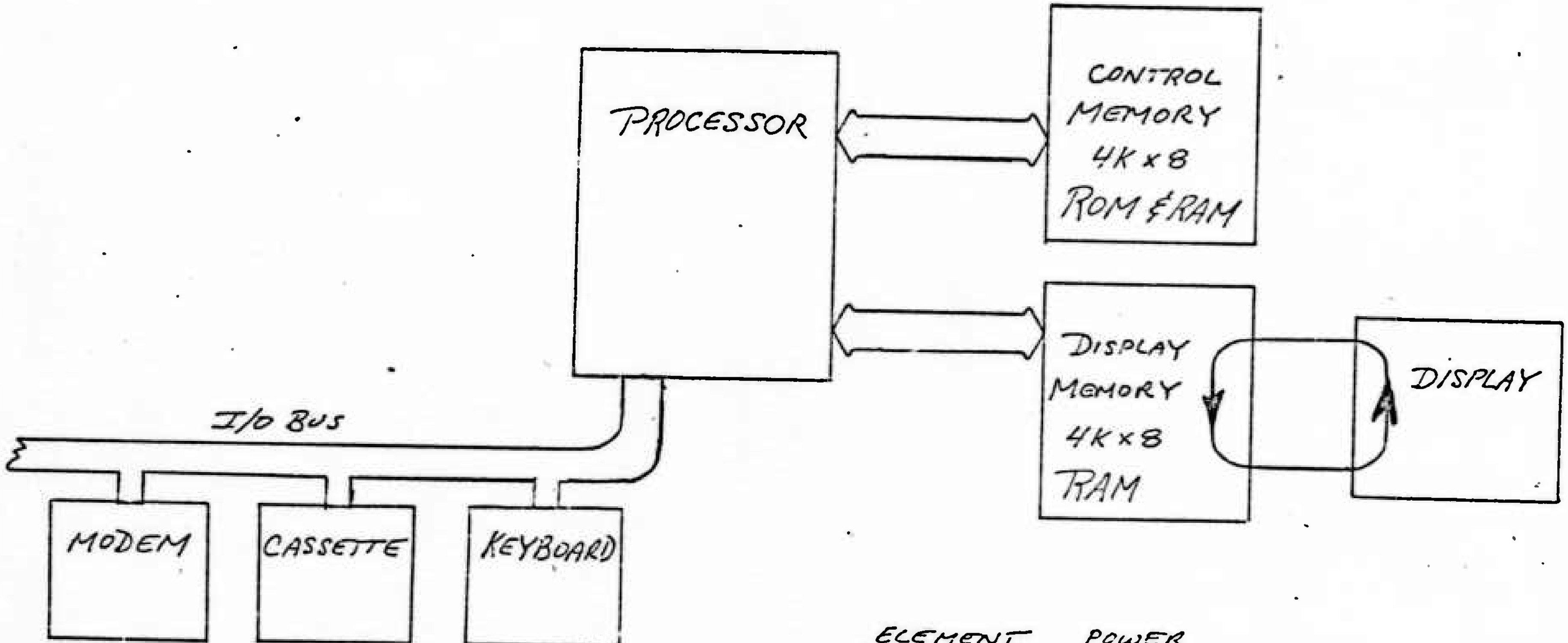
5. Control Logic - CMOS.

6. Cassette - A survey of Digital Cassette Storage Systems was conducted to assay total capability in terms of power consumption, weight, and size. The MFE Unit is consistent with the design objectives. The unit consumes 3.4 W, weighs 1.5 lbs, and occupies approximately 40 in^3.

7. Modem - RS-232 I/O circuitry.

8. Power Source - The results of preliminary studies indicated an energy requirement of approximately 100 W-Hr. A survey of battery manufacturers showed that this requirement can be satisfied with a rechargeable AG-ZN battery weighing approximately 3 pounds and occupying a volume of approximately 42 in^3.

9. Programming - TECO-like (see Figure 2).



ELEMENT	POWER
PROCESSOR	– < 100 mwatts (C-MOS) – 500 mwatts (N-MOS)
MEMORY (8K)	– 1.7 watts (?)
DISPLAY	– < 100 mwatts (Liquid Crystal) – 4.4 Watts (LED) *
KEYBOARD	– (?)
CONTROL (LOGIC)	– 200 mwatts
CASSETTE	– 3.4 watts (only when operating)
MODEM	– (?)

* 2 LINES OF 40 CHARACTERS

FIGURE 1 – ORGANIZATION

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EDITING FEATURES

Character-at-a-time editor. All operations take place in relation to cursor.

CURSOR POSITIONING

1. Forward and backward, a character or line.
2. Search for string and position cursor after string (forward and backwards search?).
3. Jump to top and bottom of text.

INSERTION AND DELETION

1. Insert character(s) at cursor position.
2. Delete forward and backward, a character or line.

MISCELLANEOUS AND OPTIONAL

1. Replace command.
2. Zero buffer (clear all).
3. Block moves (probably not practical).
4. Repeat capability (do a command N times).

INPUT/OUTPUT

1. Depends on device. Either page mode or ?

FIGURE 2 - Text Editor Features

IV. TASK II - PROGRESS TO DATE

Two INTEL 8080 Processors, each with 8K memory, were procured in support of our earlier ARPA sponsored research. These units will be used as the processors to accomplish the goals of Task II.

Presently the processors and memory are separate units. They will not be functional until the design and implementation of memory and control interface hardware is completed. This design is proceeding at present.

The sequence toward implementation has the following stages:

1. System design of Processor and Memory interface.
2. Design of communications interface to accommodate at least two I/O ports.
3. Specification of reliable transmission software with details of interconnection through certain Hosts, TIPs, or direct.
4. Assembly of two systems, one for each end of the communication link.
5. Checkout, programming, and test of the end-to-end error recovery system.

Details of system organization will be presented in a subsequent report.